REMARKS AND REQUEST FOR EXTENSION OF TIME

The applicant requests a three-month extension of time up to and including April 28, 2005 in which to file the present response. Please charge the $1,020 fee in connection with this request to our Deposit Account No. 22-0261. In the event the Examiner finds that additional fees are required, he or she is hereby authorized to charge to our Deposit Account No. 22-0261.

Reconsideration of the outstanding Office Action is respectfully solicited.

[1] Applicants respectfully request the withdrawal of the rejection of Claims 1-5 under 35 U.S.C. 112, second paragraph in view of the amendment and following remarks.

The Examiner has indicated and suggested that:

(i) Claims 1-5 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject mater which applicant regards as the invention, and

(ii) Claim 1, line 1, "a shaft sealing apparatus", how can a shaft sealing apparatus have a vacuum casing and a drive shaft. Applicant should change this language to limitation similar to --a shaft sealing assembly --.

In response to the Examiner's indication and suggestion, Claim 1 has been amended in order to particularly point out and distinctly claim the subject mater which applicants regard as the invention.

Support for the amendment to the claim 1 is based on lines 27-34 on page 1, lines 18-23 on page 17, and lines 8-13 on page 29 of the specification and the original claims. The present invention is defined in the amended claim 1 as follows:

A shaft sealing assembly for use in a vacuum processing apparatus, comprising:

(f1) a vacuum casing formed therein with a vacuum chamber maintained at a high pressure level less than 10^{-1} Pa and having a base portion formed with an opening wherein said opening provides communication between said vacuum chamber and the atmosphere;

(f2) a driving shaft having an outer cylindrical surface and movably extending in said vacuum chamber of said vacuum casing through said opening of said vacuum

casing; and

(f3) a sealing ring in the form of an annular ring shape, received in said opening of said vacuum chamber and including a sealing lip held in contact with said outer cylindrical surface of said driving shaft and formed with an annular groove , an annular spring member received in said annular groove of said sealing lip and operative to impart a force to said sealing lip to ensure that said sealing lip is held in tight contact with said outer cylindrical surface of said driving shaft, and a peripheral portion radially outwardly extending from said sealing lip and fixedly connected with said base portion of said vacuum casing,

(f4) in which said outer cylindrical surface of said driving shaft is smaller in surface roughness Ra than 0.1 (μm), and

(f5) the gap between said outer cylindrical surface of said driving shaft and said sealing lip of said sealing ring is sealed within a tolerance less than 1×10^{-9} Pa m^3/s.

Although other independent claims 6, 9 and 14 and their dependent claims had been withdrawn from consideration, the applicant wishes to amend these claims to include the limitations relating to the above features (f1), (f4) and (f5) of the amended claim 1.

[2] In the above Office Action, the Examiner also has indicated that:

(iii) Claims 1 and 3 are rejected under 35 U.S.C. 103(a) as being unpatentable over Heidrich (U.S. Patent 3,811,658) and Stephenson et al (U.S. Patent 4,586,718) in further view of DeHart et al. (U.S. Patent 4,573,690).

Heidrich discloses a shaft sealing apparatus, comprising a vacuum casing (casing formed by member 24) formed with a vacuum chamber (chamber having vacuum that is indicated by gauge 20) and having a base portion (end portion of the vacuum casing) formed with an opening to have (opening having a shaft 5 going through) the vacuum chamber held in communication with the atmosphere therethrough. A driving shaft (5) having an outer cylindrical surface and movably extending in the vacuum chamber of the vacuum casing through the opening of the vacuum casing. A sealing unit including a sealing ring (ring 9), the seal ring having an annular ring shape (the ring 9 has annular ring shape) and fixedly connected the base portion of the vacuum casing and securely retaining the peripheral portion of the searing rings. The sealing ring contacts an outer cylindrical surface of the shaft (5).

Heidrich fails to disclose that the sealing ring having a sealing lip, an annular

spring member, and a peripheral portion radially outwardly extending from the sealing lip. Stephenson discloses a seal (13) having a lip seal (13c), an annular spring member (spring 13d, which is a coil spring same type of spring as applicants spring, so the spring is made of wire in the form of a helical shape) and a peripheral portion radially outwardly extending from the sealing lip (portion 3d). It would have been obvious to one ordinary skill in the art at the time the invention was made to configure the seal of Heidrich to have a lip seal, a coil spring and a radially extending portion as taught by Stephenson, to enhance the life of the seal and the shaft (because a small portion of a seal contacts the shaft, which is the lip seal) and to apply sufficient force to a seal to provide a contact with the shaft (this is the case since the sealing ring has a spring member on the lip).

Heidrich and Stephenson disclose the invention substantially as claimed above but fail to disclose the outer cylindrical surface of the drive shaft is smaller in surface roughness Ra that 0.1 micrometer. DeHart discloses a shaft surface (pads 30 on shaft form a surface of the shaft that has a unique roughness) that is in contact with a sealing lip and the shaft surface is smaller in roughness than Ra 0.1 micrometer (Column 4, line 63). It would have been obvious to one having ordinary skill in the art at the time the invention was made to configure the outer cylindrical surface of Heidrich and Stephenson to have a surface roughness that is smaller in surface roughness Ra than o.1 micrometer as taught by DeHart, to provide an improved sealing surface (see abstract of DeHart) and to reduce seal friction (column 2, lines 5-8 of DeHart).

However, it is submitted that the rejection under U.S.C. 103(a), based on Heidrich (US Patent 3,811,658), Stephenson et al. (U.S. Patent 4,586,718) and DeHart et al. (U.S. 4,573,690) is improper and should be withdrawn for the reasons set forth herein.

The Heidrich reference

The Heidrich reference discloses a shaft seal assembly for use in an extruder for processing plastics and rubber. The extruder comprises a cylinder 2 formed with a hopper bore 3, a hopper 4 for feeding coarse plastic materials, a screw shaft 1 driven to rotate in the cylinder 2 to mix and melt the plastic materials, an extruder housing 7 formed with an opening, a screw driving shaft 6 passing through the opening of the extruder housing 7 to drive the screw shaft 1, and a vacuum tight lid 24 connected with the cylinder 2 and the extruder housing 7 to form around the screw shaft 1 an intermediate chamber 16 held in communication with hopper bore 3 through the

cylinder 2.

However, the intermediate chamber 16 is held in communication with the hopper bore 3 and the cover of the hopper 4 is not required (see column 3, lines 26-32). This leads to the fact that Heidrich fails to disclose the sealing assembly for use in a vacuum processing apparatus and the claimed features (f1) and (f2) identified above, of the present invention.

It is therefore quite difficult for the sealing assembly of the extruder taught by Heidrich to effectively seal the gap around the driving shaft in the case that the sealing assembly is provided between the highly vacuumed chamber and the atmosphere.

Although Heidrich discloses seals 8 and an additional seal 9, the details of the seals 8, 9 cannot be found in the patent specification and drawings. This means that Heidrich fails to disclose the claimed features (f3)-(f5) of the present invention.

The Stephenson et al. reference

The Stephenson et al. reference discloses a sealing assembly with floating gland means for rotatable shafts. The sealing assembly comprises a pump casing 11, a rotatable shaft 12, a sealing ring 13 provided between the pump casing 11 and the rotatable shaft 12, a floating gland 14 to which the high pressure environment is directed along the rotatable shaft 12. The sealing ring 13 has a body portion 13a, a flange portion 13b and a lip seal portion 13c and also receives a coiled spring 13d, while the gland 14 is formed with an opening 14a and first and second recesses 14b, 14c having the body portion 13a of the sealing ring 13 received therein.

The pump housing 11 is however designed to introduce high pressure around the rotatable shaft 12, and the high pressure is exerted on the sealing ring 13 directly through the gap between the gland 14 and the rotatable shaft 12. Consequently, Stephenson et al. fails not only to disclose the claimed features (f1) through (f5) of the present invention. but also does not disclose the shaft sealing assembly for use in the vacuum processing apparatus which is operated under the pressure less than 10^{-1} Pa.

It is impossible for the sealing assembly taught by Stephenson et al to effectively seal the gap around the driving shaft even if the sealing assembly is provided between the highly vacuumed chamber and the atmosphere.

In contrast, the sealing assembly according to the claimed invention makes it possible to effectively seal the gap around the driving shaft between the highly

vacuumed chamber and the atmosphere under the state that the driving shaft is movably extending in the vacuum chamber through the opening of the vacuum casing.

The DeHart reference

Regarding DeHart, the Examiner has indicated that DeHart discloses a shaft surface 12 (pads 30 on shaft) that is in contact with a sealing lip and smaller in roughness than Ra of 0.1 micrometer (column 4, line 63).

The shaft surface 12 taught by DeHart is, however, formed with a plurality of indentations 28 which are uniformly spaced along the path of relative motion between the seal lip 26 and the sealing surface 12(column 4, lines 19-26) and each of which has a width Iw approximately 0.263 mm and a depth approximately 0.025 mm. This shaft surface 12 is so designed as to create a lubricant film between the seal lip and the sealing surface 12 especially in the indentations 28. As such, it is apparent that the shaft surface taught by DeHart is entirely different from that smaller in roughness than Ra of 0.1 micrometer despite that the pads 30 forming part of the shaft surface are smaller in roughness than Ra of 0.1 micrometer.

In addition, because of the existence of the plurality of indentations 28 spaced along the path of the relative motion between the seal lip 26 and the sealing surface 12, the gap between the sealing lip 26 and the sealing surface 12 of the shaft 10 taught by DeHart far exceeds a volume in comparison with the volume of the gap between the sealing lip and the driving shaft of the claimed invention. This arrangement significantly diminishes the performance of the seal 20 taught by DeHart during the relative motion between the seal lip 26 and the sealing surface 12 in the case where the sealing surface is employed to seal the gap between the highly vacuumed chamber and the atmosphere.

The reference to DeHart, consequently, does not teach the above essential features (f4) and (f5) of the present invention. And, it is also apparent that DeHart fails to teach or suggest the claimed features (f1) - (f3) of the present invention.

Furthermore, the sealing lip 26 of the Dehart device is held in pressing contact only with the pads 30 and is therefore liable to be elastically deformed due to the existence of the plurality of indentations 28. In contrast, the sealing assembly according to the claimed invention makes it possible to effectively seal the gap around the driving shaft between the highly vacuumed chamber and the atmosphere under the

state that the driving shaft is movably extending in the vacuum chamber through the opening of the vacuum casing. In other words, the outer cylindrical surface of the driving shaft smaller in surface roughness Ra than 0.1 μm makes it possible to achieve excellent performance with respect to sealing the gap between the driving shaft and the seal lip of the sealing ring around the driving shaft within a severe tolerance less than 1×10^{-9} Pa m^3/s (See lines 18-23 on page 17 of the specification) under the condition that the vacuum chamber is maintained at a high pressure level less than 10^{-1} Pa.

It will therefore be apparent that it would not have been obvious to one ordinary skill in the art at the time the invention was made to configure the outer cylindrical surface of the shaft of Heidrich and Stephenson to provide an improved sealing surface of the shaft sealing assembly for use in a vacuum processing apparatus maintained at a high pressure level less than 10^{-1} Pa.

Accordingly, it is submitted that the claimed invention would not have been obvious to one ordinary skill in the art at the time the invention was made because there was nothing to tech or suggest configure the outer cylindrical surface to have a surface roughness that is smaller in surface roughness Ra than 0.1 micrometer.

[3] The Examiner has further indicated that:

(iv) Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Heidrich, Stephenson, and DeHart as applied to claim 1 above, and further in view of Aihara (U.S. No. 5,853,502).

Heidrich, Stephenson and DeHart disclose the invention substantially as claimed above but fail to disclose that the outer cylindrical surface of the shaft to have hardness larger than Hv 650. Aihara teaches to have a shaft to have a cylindrical surface that has hardness larger than Hv 650. It would have been obvious to one having ordinary skill in the art at the time the invention was made to configure the outer cylindrical surface of the shaft of Heidrich, Stephenson and Dehart to have hardness larger than Hv 650, to provide better strength and excellent hardness as required by a particular environment (see Aihara).

Reconsideration of the rejection is respectfully requested. It is submitted that that the rejection under U.S.C 103(a), based on Heidrich (US Patent No. 3,811,658), Stephenson et al. (U.S. Patent No. 4,586,718), DeHart et al. (U.S. patent No. 4,573,690) and Aihara (U.S. Patent No. 5,853,502) is improper and should be

withdrawn for the following reasons.

The Aihara reference

The Aihara reference discloses a constant velocity universal joint for the drive shaft of the automobile, and teaches providing a rolling contact surface not like a sealing surface as disclosed and claimed. In particular, Aihara provides:

> If the surface hardness of parts after carburizing and quenching is lower than Hv 650, resistance against rolling contact fatigue deteriorates. Therefore, for high strength joint parts which are used under high surface pressure as compared to conventional situations, resistance against rolling contact fatigue is insufficient. For the reasons described above, the surface hardness of parts of the constant velocity joints for drive shafts is determined to between Hv 650 and Hv 850. (See column 10, lines 46-54, *emphasis added*)
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> The roughness of the rolling surface greatly affects the service life of the ball case. (See column 6, lines 48-49 *emphasis added)*

Thus, Aihara only teaches a proper surface hardness of the inner race of the universal joint sufficient to have resistance against rolling contact between the inner race 4 and balls 5. Aihara, therefore, neither teaches nor suggests a specific environment leading to a motivation to provide strength and excellent sealing level of the shaft surface and the sealing lip as disclosed and claimed.

According to the present invention defined on claim 2, on the other hand, the combination of a surface roughness that is smaller in roughness Ra than 0.1 μm and a hardness that is larger in Vickers hardness Hv than 650 makes it possible for a long time to be excellent in characteristic to seal the gap between the driving shaft and the sealing lip within a severe tolerance less than 1×10^{-9} Pa m^3/s. (See lines 18-23 on page 17 of the specification)

As a consequence, the obvious rejection is improper. One with ordinary skill in the art at the time the invention was made would not have configured the outer cylindrical surface of the shaft of Heidrich, Stephenson and DeHart to have hardness larger than Hv 650 to provide better strength and excellent hardness as required by a particular environment without first understanding the applicant's invention.

The combination of the seal taught by Heidrich and Stephenson and the shaft surface taught by DeHart and Aihara as indicated by the Examiner is therefore only

achieved using impermissible hindsight.

[4] The Examiner has yet further indicated that:

> *(iv) Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Heidrich, Stephenson, and DeHart as applied to claim 1 above, and further in view of Reinsma (US. Patent No. 4,331,339).*
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> *Heidrich, Stephenson and DeHart disclose the invention substantially as claimed above but fail to disclose the sealing lip of the sealing ring is made of a synthetic resin constituted by an ultra high molecular weight compound. Reinsma teaches to have a seal made from synthetic resin constituted by an ultra high molecular weight compound (column 4, lines 1-10). It would have been obvious to one having ordinary skill in the art at the time the invention was made to configure the sealing lip of Heidrich, Stephenson and DeHart to be formed of a synthetic resin constituted by an ultra high molecular weight compound as taught by Reinsma, to provide stronger lip seal (abstract of Reinsma).*

Reconsideration of the rejection is respectfully requested. It is submitted that the rejection under U.S.C 103(a), based on Heidrich (U.S. Patent No. 3,811,658), Stephenson et al. (U.S. Patent No. 4,586,718), DeHart et al (U.S. patent No. 4,573,690) and Reinsma (U.S. Patent No. 4,331,339) is improper and should be withdrawn in view of the following remarks.

The Reinsma reference

The Reinsma reference discloses an end face seal assembly provided with an earthmoving vehicle or the like used in severe service environments. The seal assembly includes an annular thrust sealing member 36 to exclude external contaminants from a joint 12 between relatively movable members 14, 22 .

The thrust sealing member 36 is made from a thermoplastic resin selected from the group consisting of a polyamide polymer and an ultra-high molecular weight polyethylene, and is received in the outer link 14 to be held in sealing engagement with the end face of the bushing 22 having the track pin 20 received therein.

Reinsma, however, fails to teach any one of a sealing ring received in the opening of the vacuum chamber, a sealing lip held in contact with the outer cylindrical surface of the driving shaft, an annular spring member operative to impart a force to the

sealing lip to ensure that the sealing lip is held in tight contact with the outer cylindrical surface of the driving shaft, and a peripheral portion radially outwardly extending from the sealing lip and fixedly connected with said base portion of said vacuum casing.

As set forth above, it would not have been obvious to one ordinary skill in the art at the time the invention was made to configure the outer cylindrical surface to have a surface roughness that is smaller in surface roughness Ra than 0.1 micrometer and larger in Vickers hardness Hv than 650 to provide an improved shaft seal assembly for use in a vacuum processing apparatus maintained at a high pressure level less than 10^{-1} Pa.

According to the present invention, the combination of the sealing ring and the outer cylindrical surface as defined in claim 5 makes it possible to achieve excellent sealing characteristics with respect to the gap between the driving shaft and other sealing parts around the driving shaft within a severe tolerance less than 1×10^{-9} Pa m^3/s. The flow of leakage gas can be substantially checked between the highly vacuumed chamber and the atmosphere around the driving shaft. This effect cannot be obtained by merely using an ultra-high molecular sealing lip with the shaft surface larger in surface roughness Ra than 0.1 micrometer or the shaft surface taught by DeHart.

[5] As will be understood from the foregoing description, all of the Examiner's effective references fail to indicate or suggest the above essential features (f1) to (f5) of the present invention.

Accordingly, it is believed that the present invention defined in the amended claim 1 is patentably distinguishable over the prior art of record and therefore in condition for allowance. The claims 2, 3 and 5 each dependent upon the amended claim 1 are therefore believed to be allowable.

The present invention claimed in other claims 4 and 6-20 amended to include the features similar to the features (f1) to (f5) as recited above are also believed to be allowable. In view of the amendment, it is submitted that the application is now in condition for allowance. Reconsideration of all the rejections is therefore requested and an early notice of allowance is respectfully solicited.

Respectfully submitted,

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